Tunable Lasing from a Cholesteric Liquid Crystal Film Based on Chiral Reactive Mesogen

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Cholesteric liquid crystals (CLCs) exhibit many remarkable properties due to the existence of their spontaneous self-assembly of a periodic helical structure. The lasing properties of CLCs have recently attracted great interest [1-5], because their helical structure can be regarded as a simple one-dimensional (1D) photonic gap media [1]. The periodic helical structure leads to a periodic modulation of the refractive index and results in a selective reflection band. The laser emission in dye-doped CLC (DDCLC) systems primarily occurs at the band-edge wavelength of the selective reflection band [1], where the photon density of states is enhanced. Since the selective reflection band of CLC layers can be controlled by external fields such as electric voltage, temperature, and mechanical stress, etc. Multi-wavelength lasers based on DDCLCs [2-5] have been recently subject to considerable attention and various approaches have been conducted. In almost all of the tuning methods proposed to date, the tunable lasing emission has been achieved by changing the helical pitch [2-5]. Lin et al. and Schmidtke et al. have demonstrated multi-wavelength lasers in a DDCLC based on temperature-induced oversaturated chiral dopant [3] and polymer network [4], respectively. A multi-wavelength laser from a dye-doped cholesteric polymer film (CPL) was also obtained by multiple Bragg reflections [5].

In this paper, we demonstrated a novel and simple technology to make a multi-wavelength laser from DDCLCs with the multi-domain structure, which was achieved by the reactive mesogen with chirality in the LC layer. The reactive mesogen (RM) with chirality was utilized to blend the LC mixture, and the pitch of the CLC is controlled by the doping concentration of the RM monomers. When the reactive mesogen is exposed under UV irradiation, these reactive CLC molecules tend to be arranged in helices, and their CLC structures are stabilized after UV curing. In the multi-domain DDCLC structure, every domain provides a photonic band edge to achieve laser emission. Based on the polymerization-induced phase separation (PIPS) of RMs in CLCs, the multidomain structure induced by the polymer network can be controlled by the RM-doped concentration and the UV curing time. Consequently, multi-wavelength lasing in CLC system can be easily realized by controlling the PIPS process of RM/LC mixture.

References:

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